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Nutritive Value of Dried Beet Pulp*

By N. F. Colovos and H. A. Davis†

The sugar beet, of which the main product is sugar, a very important energy food for humans, has another by-product, dried beet pulp, which is used as a feed ingredient for livestock rations.

Beet pulp is the remainder of the vegetable portion of the sugar beet after the sugar is removed from it in the processing plant. Some sugar beet pulp is used for livestock feeding in the wet form by farmers in local plant areas, but most of it is sold as dried beet pulp after most of the moisture is removed by mechanical pressure and evaporation. Dried beet pulp, therefore, is considered a concentrated feed for livestock.

Dried beet pulp has been widely used as a feed ingredient in livestock feeds for years. Dairy farmers have found it to be a highly nutritious, palatable, and highly absorptive dairy ration ingredient which contributes to maintaining a high level of production and reproduction. It is also believed that dried beet pulp aids in increasing the digestibility of the other ingredients of the ration.

While many feeding trials and practical experience have shown that dried beet pulp is a satisfactory feed for dairy cattle and has been accepted as such for many years, there is very little work in the literature where its nutritive value has been determined with cattle. About the only early work on dried beet pulp was that of Lindsey (3) who reported in 1913 that dried beet pulp is a high carbohydrate feed, similar to corn meal and that while the carbohydrates of the corn consist largely of starch, the dried beet pulp has a relatively high percentage of fiber.

Some ten years later Rothwell (5) reported results that indicated that dried beet pulp may be used to replace portions of the grain in the ration.

The digestion and utilization experiments carried out and reported in this study were for the purpose of determining the nutritive value of beet pulp by all conventional methods of nutritive evaluation as well as by directly determining its metabolizable and net energy values.

EXPERIMENTAL

Rations and Animals

The nutritive value of dried beet pulp was determined by digestion and utilization studies carried out at the Ritzman Animal Nutrition Laboratory of the Department of Dairy Science of the New Hampshire Agricultural Experiment Station. Four Holstein steers about 18 months of age, a set of twins and two males of a set of quadruplets were used as experimental animals. In order to evaluate the dried beet pulp under

* Research was partially supported by a grant from the Farmers and Manufacturers Beet Sugar Association, Saginaw, Michigan.

† Professor of Dairy Science and Associate Professor of Biochemistry, respectively.

different typical feeding conditions and in order to bring out any possible associative effects it may have with other ingredients, the general plan of experiment as shown in Table 2 was followed. The three rations, beet pulp alone, beet pulp and hay (50-0), and beet pulp, hay, and concentrate mixture (50-25-25) were fed to each of the four animals. The nutritive value of the hay, fed alone, was determined in a previous experiment with four animals.

The dried beet pulp used for the experiment was representative of United States production. It came from a plant in the eastern beet sugar section and was from the early part of the 1961 production. The composition of this dried beet pulp did not differ very much from the composition of beet pulp as reported by Morrison (4) and Schneider (6) except that it had a little higher crude fiber content.

The hay used was early cut timothy of high quality as indicated by analysis in Table 1. The concentrate mixture used had a protein content of about 18 percent. The chemical composition of these feeds is shown in Table 1.

Mineralized salt was available to the animals at all times. They were offered water and fed twice daily.

Methods Employed

The method used to study the nutritive value of the different rations is the standard procedure followed in this laboratory. It consists of the following:

1. *Preliminary period.* This is the adjustment period of 15-18 days during which the animal becomes accustomed to the kind and amount of feed to be evaluated. The level of nutrition at which the nutritive value is determined is slightly above maintenance.

2. *Collection period.* This period lasts 8-10 days. During this time the feed, feces, and urine are weighed, sampled, and a composite sample of each is kept for analysis. The feces are frozen solid and the urine is kept in a refrigerator just above freezing. No preservative is used for either the feces or urine.

3. *Heat production measurement on feed.* The animal is put in the respiration chamber, fed the same amount of feed as during the collection period, and its heat and methane production measured. By means of an "electric eye" the changes of position of the animal and the time the animal spends standing and lying are recorded. Unless the activity is adjudged to be normal, the period of measurement is repeated until at least 24 hours of heat production on feed is obtained.

4. *Heat production on fast.* The heat production of the animal is measured after it has been fasted for 48 hours. A post-absorptive condition is considered to have been reached when methane ceases to be produced and the respiratory quotient (ratio of carbon dioxide produced to oxygen consumed) is 0.75 or less. At the level of nutrition of this experiment, this is reached at 48 hours after feeding.

The difference between heat production on feed and heat production on fast is the heat increment of the ration or "work of digestion" as it is called by some.

Chemical and Caloric Analyses

A proximate analysis of representative samples of the components of the ration as fed were made by methods prescribed in the ninth edition "Book of Methods," Association of Official Agricultural Chemists. Also composite air-dried feces were analyzed by the same methods to calculate the total digestible nutrients of the rations.

Nitrogen determinations were made on the fresh feces and urine to complete the nitrogen balance of the rations.

The gross energy of the feeds, feces, and urine was obtained by means of an adiabatic bomb calorimeter. The caloric determination of the fresh feces was made according to the method described by Colovos et al. (1).

RESULTS AND DISCUSSION

Table 3 shows the average digestion coefficients for the four rations as fed. The dried beet pulp was significantly higher than the other rations in digestibility of the dry matter, energy, crude fiber, and nitrogen free extract. The digestibility of the protein in the dried beet pulp was lower and the ether extract was significantly lower. The digestion coefficients of the protein, fiber, and nitrogen-free extract of the dried beet pulp were higher than those reported by Morrison (4).

The digestibility of the protein of the hay used in the experiment, when fed as the sole ration, was higher than for the other three rations. This value confirms previous results in this laboratory with early-cut, well fertilized timothy hay (2).

The average daily feed intake and gain in protein and energy on each ration is shown in Table 4. Dried beet pulp fed alone showed a significantly higher daily energy balance per unit basis than the other rations. This was more or less expected due to the fact that dried pulp is a high carbohydrate feed. The high retention of nitrogen, however, was unexpected. Even though dried beet pulp did not have a very high protein content, the amount eliminated in the urine was so low that a relative high percentage of it was retained and the total retention was higher than on any of the other rations.

The average nutritive values of the dried beet pulp when fed alone, in combination with hay, and with hay and a concentrate mixture are shown in Table 5. Beside the conventional total digestible nutrients and digestible energy values, metabolizable energy, and also net energy figures are shown.

The dried beet pulp had a higher value for total digestible nutrient content than any of the other rations despite the fact that it was very low in fat content. This value was higher than the values commonly reported for beet pulp. The dried beet pulp also excelled the other rations when the comparison was made on either the digestible energy, metabolizable energy, or net energy basis.

Summary and Conclusion

Sixteen digestion and utilization experiments with four Holstein steers were carried out to determine the nutritive value of dried beet pulp fed alone, in a 50-50 ratio with hay, and with hay and a concen-

trate mixture. It was found that the dried beet pulp is a highly digestible concentrate ingredient. As fed, it contained 4.24 per cent digestible protein, 70.93 per cent total digestible nutrients and 78.3 therms net energy per 100 lbs. The protein content of the dried beet pulp is in the range of that of corn and it is well utilized.

The results of the experiment show that dried beet pulp is an excellent source of energy for dairy cattle when fed with hay or as part of the concentrate mixture.

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Table 1. Chemical Composition of Feeds

%	Beet Pulp	Hay	Concentrate Mixture
Protein	8.02	11.73	17.86
Ether extract	0.44	2.60	2.95
Crude fiber	23.32	34.01	8.90
N.F.E.	54.61	35.20	51.34
Ash	4.20	7.36	7.33
Moisture	9.41	9.10	11.62

Table 2. General Plan of Experiment

Animal*	Period 1	Period 2	Period 3
H 509	Beet pulp + hay + concentrate	Beet pulp alone	Beet pulp+ hay
H 510	Beet pulp alone	Beet pulp + hay + concentrate	Beet pulp + hay
H 557	Beet pulp + hay	Beet pulp + hay + concentrate	Beet pulp alone
H 558	Beet pulp alone	Beet pulp + hay	Beet pulp + hay + concentrate

* Holsteins

Table 3. Average Digestion Coefficients for Various Rations

Feed	Dry Matter	Energy	Protein	Ether Extract	Crude Fiber	Nitrogen-free Extract
				%		
Beet pulp alone	79.04	78.22	52.91	0	77.75	88.62
Beet pulp + hay	72.91	71.10	53.17	20.40	75.44	79.18
Beet pulp + hay + concentrate	71.91	70.92	58.31	38.50	71.02	79.57
Hay*	65.93	55.95	61.75	56.31	73.29	65.64

* Nutritive evaluation was made in previous experiment.

Table 4. Average Daily Feed Intake and Gain in Protein and Energy on Each Ration

Feed	Average Daily Wt. Fed	Protein	Energy
	g.	g.	Cal.
Beet pulp alone	7020	+ 149	+ 3278
Beet pulp + hay, 53-47	7279	+ 118	+ 1766
Beet pulp + hay + concentrate, 50-25-25	7720	+ 107	+ 3339
Hay, sole ration	6000	+ 115	— 188

Table 5. Nutritive Value of Beet Pulp Rations*

Feed	TDN	Digestible Energy	Metabolizable Energy	Net Energy
	%	Therms per 100 lb.	Therms per 100 lb.	Therms per 100 lb.
Beet pulp alone	78.30	150.3	136.4	86.4
Beet pulp + hay	69.64	138.8	119.5	77.4
Beet pulp + hay + concentrate	69.83	137.8	119.2	81.1
Hay used in experiment	63.94	112.0	87.9	48.3

* Values expressed on dry matter basis.